

San Juan Islands
Acoustical Monitoring Summary
Summer 2016

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Contents

Acknowledgements

Introduction

Study Area

Methods

Automatic monitoring

Calculation of metrics

Off-site Listening/Analysis

Results

Discussion

Conclusion

Appendix

Appendix A: List of Acoustic terms

Appendix B: Site Photos

Appendix C: Figures

Appendix D: Tables

Literature cited

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Introduction

In the summer of 2016 two sites in the San Juan Islands were selected to conduct acoustical resource monitoring. The project was coordinated by the Bureau of Land Management (BLM) and was a collaborative effort between the BLM and the National Park Service (NPS). The equipment and procedure used for the acoustical monitoring was provided by the NPS Natural Sounds and Night Skies Division (NSNSD). The objective of the project was to provide a baseline for understanding the acoustical environment of the select locations on public lands in the San Juans in order for the BLM, NPS and other public lands organizations to make more informed management decisions in the future.

This summary, while connected to the BLM baseline inventory project, is a separate report that focuses on the military and commercial aircraft overflights during the monitoring period. Given the proposed increase in EA-18G Growler (Growlers) jet activity in the area from the Naval Air Station Whidbey Island, it seemed an appropriate time to gather acoustical information on the potential impacts of Growlers at the monitoring sites.

Study Area

For the acoustical monitoring project two sites were selected, LOPEZ001 and SANJ001. The first site, LOPEZ001, was located on the south end of Lopez Island at Point Colville, a San Juan Islands National Monument (SJINM) land managed by the BLM. The equipment was set up 50m from the water in a small clearing along the edge of the forest, shielded from view of the trail by several trees and rocky bluffs. The second site, SANJ001, was located on San Juan Island at American Camp, a NPS National Historic Park. SANJ001 was set up 500m from the Jackles Lagoon trailhead, 20m off the trail in a small clearing along the edge of the forest with a denser forest to the north and an open field to the south.

Table 1. Locations of recording equipment in the San Juan Islands.

Site	Location	Dates	Vegetation	Elevation	Latitude	Longitude
LOPEZ001	Point Colville, Lopez	8/4/2016 - 8/31/2016	Temperate Coniferous Forest	24.4 m	48.4221	-122.8143
SANJ001	American Camp, San Juan	9/8/2016 - 9/27/2016	Temperate Coniferous Forest	50.6 m	48.2771	-122.5966

The acoustic monitoring stations were set up to measure acoustic conditions in order to gain a better understanding of the acoustic environment in each location. As the BLM has not gathered any data on the natural sounds on any SJINM land before, this study may be a useful resource for the BLM in making more informed management decisions in the future. Natural sounds are one of the many resources that make the SJINM so culturally and environmentally significant. With an increase in human activity and anthropogenic sound sources it is important to gather data on the acoustical environment on public lands in the San Juans in order to preserve them for future generations.

While a more thorough baseline inventory report will be produced from the data gathered, this report has used the data gathered in order to focus on the occurrence of military and commercial aircraft events. With the proposed increase in activity from the Naval Air Station on Whidbey Island, it seemed an appropriate time to gather acoustical information on the potential impacts of EA-18G Growler jets at the monitoring sites.

Methods

Sound Monitoring

At each of the sites a Larson Davis 831 sound level meter (SLM) was employed for 3-4 weeks.* The Larson Davis SLM is a hardware-based, real-time analyzer that constantly records one second sound pressure level and 1/3 octave band data. The Larson Davis instrument meets Type I standards for the American National Standards Institute (ANSI). The sound level meter gathered the information needed to calculate the metrics described in the "Calculation of Metrics" section below.

The monitoring stations included:

- Microphone with environmental shroud
- Preamplifier
- 3.2 V LiFe rechargeable battery packs
- Anemometer (wind speed)
- MP3 digital audio recorder (DAR)

The monitoring stations collected:

- SPL data in the form of A-weighted decibel readings (dBA) every second
- Continuous digital audio recordings
- One third octave band data every second ranging from 12.5 Hz – 20,000 Hz
- Wind speed

Calculation of Metrics (Writing in blue is from Ebey's Landing Report)

The status of the acoustical environment can be characterized by spectral measurements, durations, and overall sound levels (intensities). Descriptive figures and metrics can be used to interpret these characteristics. A fundamental descriptor is existing ambient (L_{50}) sound levels. Existing ambient or L_{50} is an example of an exceedance level, where an L_x level refers to the SPLs that are exceeded x% of the time. The L_{50} represents the median sound pressure level, and is comprised of spectra (in dB) drawn from a full dataset (removing data with wind speed > 5m/s to eliminate error from microphone

*The equipment was meant to be deployed for 25-30 days, however, the batteries lost their charge sooner than expected. As result the equipment was recording at LOPEZ001 for roughly 27 days at SANJ001 for roughly 20 days, depending on the hour of set up and take down.

distortion.). Another example, the L_{90} , represents the sound pressure level that is exceeded 90% of the time, therefore, only 10% of the sound levels that occur are below the L_{90} . LAeq (A-weighted equivalent continuous sound level) is another important metric that shows an average SPL over the monitoring period. Day-Night Level (L_{dn}) is also provided in this report, sometimes referred to as DNL. This metric was calculated from hourly LAeq of the monitoring period with the hours from 22:00 to 7:00 increased by 10 dB.

The Department of Defense has found another metric useful to supplement DNL analysis for military aircraft. A useful way to describe aircraft noise is to provide the total number of noise events that exceed a selected Maximum A-weighted Sound Pressure Level (L_{Amax}) (Department of Defense, 2009). NPS chose 70 dBA L_{Amax} because this level is likely to interfere with conversation among park visitors and employees including interpretive talks.

Off-Site Listening/Analysis

Auditory and visual analysis was used to calculate the audibility of sound sources at the Reserve. Trained technicians at Colorado State University analyzed 31 days of data collected from the sound pressure level meter and MP3 recorder deployed at each site. From the SPL data, spectrograms were created with the accompanying recorded audio (Figures 4, 5, 6, and 7). Spectrograms are plots that display sound level as a function of time and frequency. Since aircraft have a recognizable sound signature, they are visually identifiable on spectrograms. Individual events can be isolated and analyzed. For every noise event the user is able to record beginning and end times, frequencies spanned, maximum sound pressure level, and sound exposure level (SEL). This dataset also included continuous audio that can be played for events with questionable sound signatures. This method uses a platform created for sound pressure level annotation referred to as SPLAT by NSNSD. Bose Quiet Comfort Noise Canceling headphones were used for off-site audio playback to minimize limitations imposed by the office acoustic environment.

Results:

See Tables and Figures below and compare to Ebey's Landing Report to put them in context. A similar analysis will be done for this report as soon as possible.

Tables

Table 2. The number of aircraft events for each site and the daily average time audible for military aircrafts during the monitoring period at each site location.

Site	Location	Commercial Aircraft Events	Military Aircraft Events*	Daily average time audible for military aircrafts (00:00/%)
LOPEZ001	Point Coleville, Lopez	218	1,107	1:58/8.19%
SANJ001	American Camp, San Juan	265	333	00:30/2.08%

* A single military aircraft may have resulted in multiple events depending on the flight path.

Table 2. Effects at discrete acoustic levels.¹

SPL (dBA)	Relevance
35	Blood pressure and heart rate increase in sleeping humans (Haralabidis et al., 2008) ¹ Desired background sound level in classrooms (ANSI S12.60-2002)
45	World Health Organization's recommendation for maximum noise levels inside bedrooms (Berglund, Lindvall, and Schwela, 1999)
52	Speech interference for interpretive programs (U.S. Environmental Protection Agency, 1974)
60	Speech interruption for normal conversation (U.S. Environmental Protection Agency, 1974)

¹ The authors of Haralabidis use both dB and dBA in this paper and LAeq (an A-weighted Measurement), since A weighting is the industry standard we assumed their decibel measurements are A-weighted for the referenced data.

¹ Pipkin, A. 2016. Ebey's Landing National Historical Reserve: Acoustical monitoring report. Natural Resource Report NPS/ELBA/NRR—2016/1299. National Park Service, Fort Collins, Colorado.

Table 3. Percent time above sound levels, represented in a truncated (T) frequency range and the full measured frequency range, for daytime and nighttime during the monitoring period.

Site	(Hz)	% time above sound level: 07:00 - 19:00				% time above sound level: 19:00 - 07:00			
		35dBA	45dBA	52dBA	60dBA	35dBA	45dBA	52dBA	60dBA
LOPEZ001	20-1250 (T)	53.14	11.05	2.74	0.2	29.9	5.09	0.42	0
	12.5-20,000	55.25	11.27	2.93	0.24	33.35	5.88	0.45	0.01
SANJ001	20-1250 (T)	34.55	5.34	1.66	0.31	12.39	0.94	0.16	0.02
	12.5-20,000	42.05	6.07	1.85	0.33	15.06	1.03	0.27	0.03

Table 4. Exceedance levels for existing conditions in EBLA, for daytime and nighttime in a truncated (T) frequency range and the full measured frequency range, for daytime and nighttime during the monitoring period.

Site	Frequency (Hz)	Exceedance levels (dBA): 07:00-19:00			Exceedance levels (dBA): 19:00-07:00		
		L90	L50	L10	L90	L50	L10
LOPEZ001	20-1250 (T)	31.2	35.3	43.6	28.2	31.4	36.1
	12.5-20,000	31.7	35.8	43.8	29	32	36.9
SANJ001	20-1250 (T)	29.2	32.7	41.6	21.1	25.1	31.2
	12.5-20,000	30.4	33.6	42.2	22.6	26.1	32.2

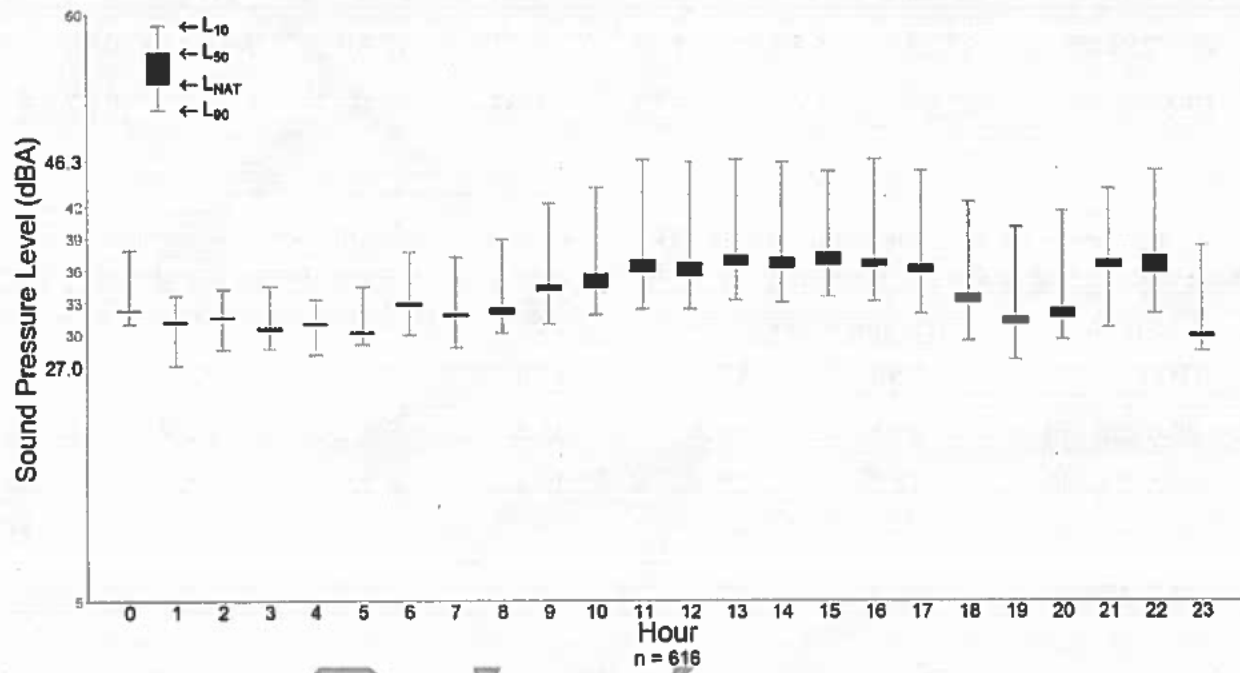
Table 5. Sound pressure level examples.¹

Park Sound Sources	Common Sound Sources	dBA
Volcano crater (Haleakala National Park)	Human breathing at 3m	10
Leaves rustling (Canyonlands National Park)	Whispering	20
Crickets at 5m (Zion National Park)	Residential area at night	40
Conversation at 5m (Whitman Mission National Historic Site)	Busy restaurant	60
Snowcoach at 30m (Yellowstone National Park)	Curbside of busy street	80
Thunder (Arches National Park)	Jackhammer at 2m	100
Military jet at 100m Above Ground Level (Yukon-Charley Rivers National Preserve)	Train horn at 1m	120

¹ Pipkin, A. 2016. Ebey's Landing National Historical Reserve: Acoustical monitoring report. Natural Resource Report NPS/ELBA/NRR—2016/1299. National Park Service, Fort Collins, Colorado.

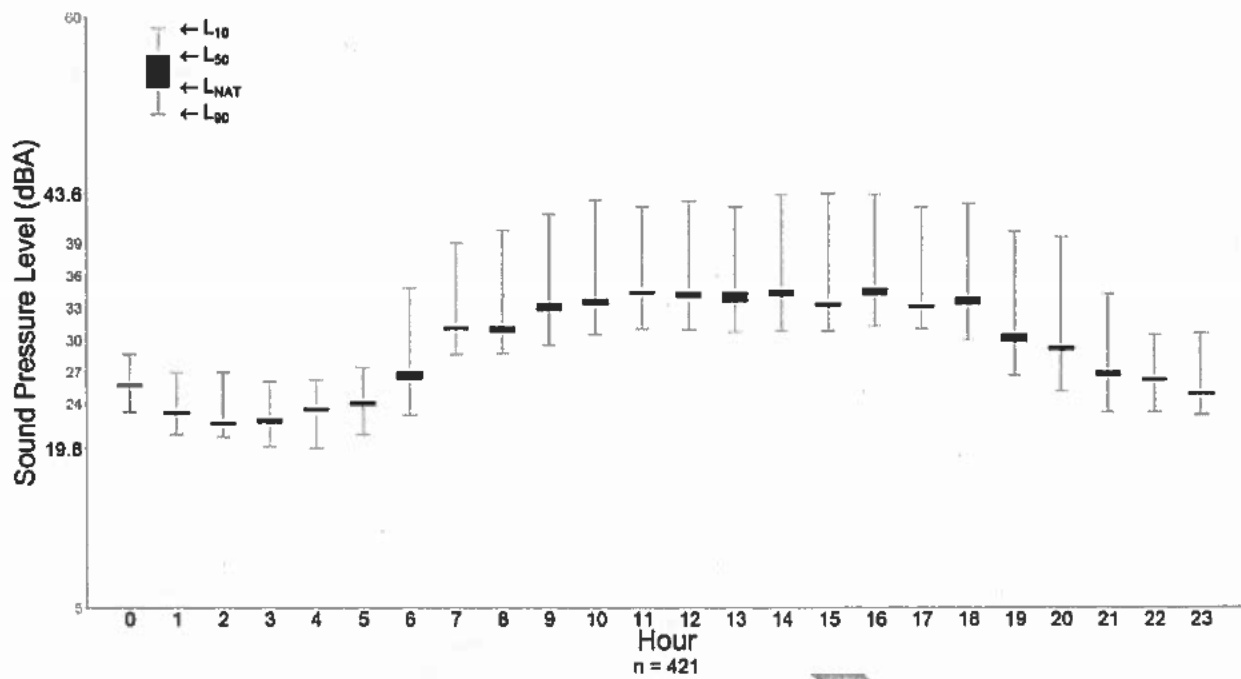
Figures

LOPEZ001

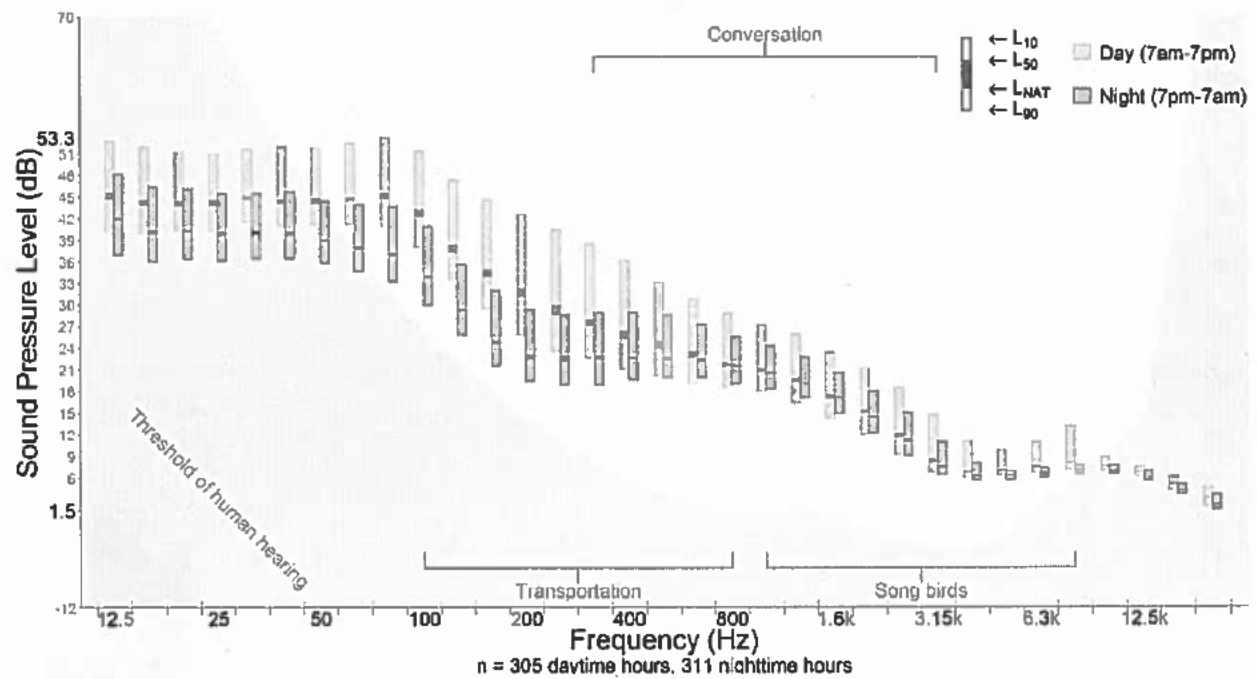


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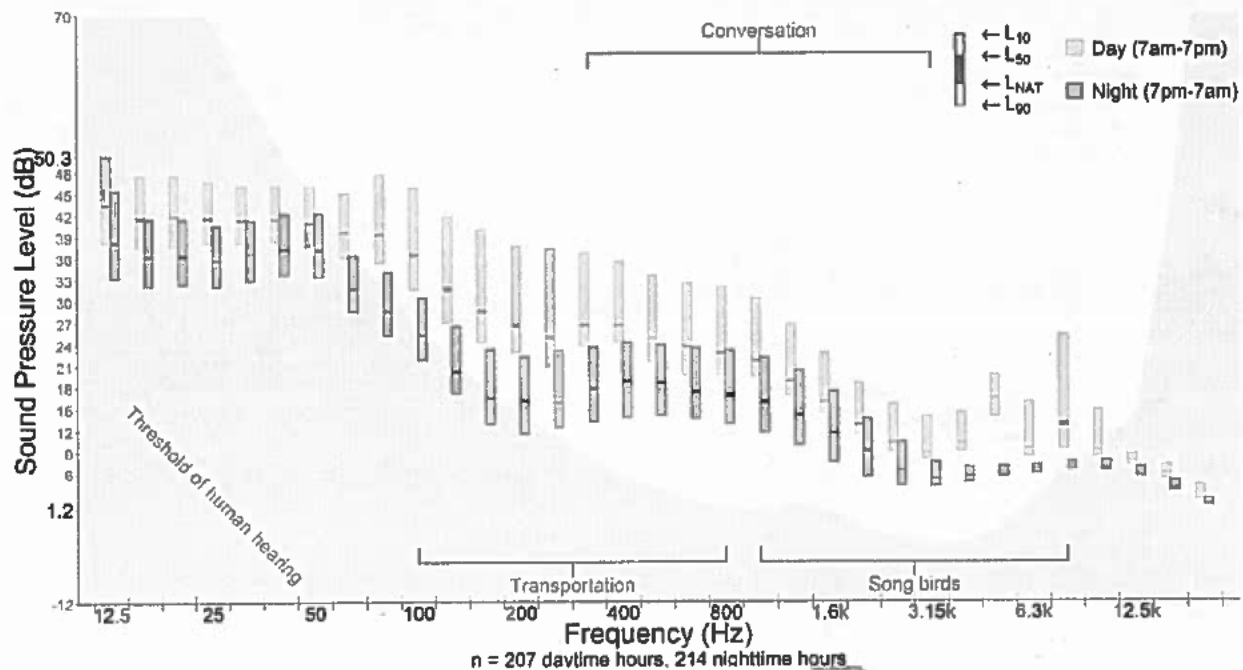
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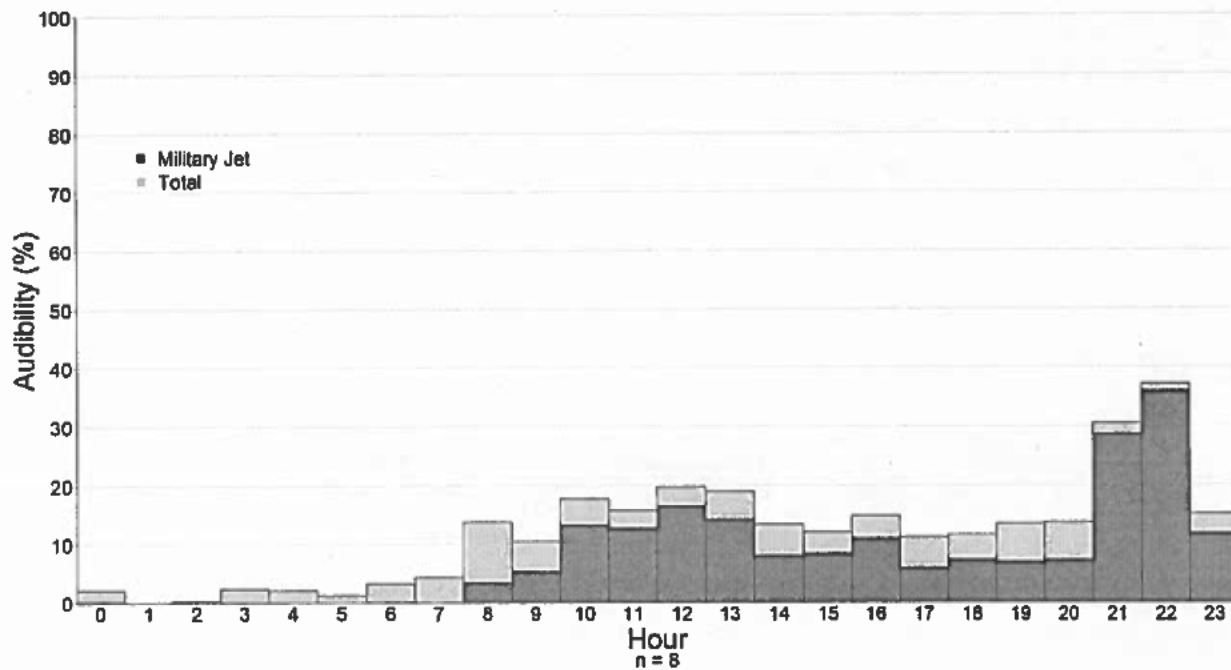
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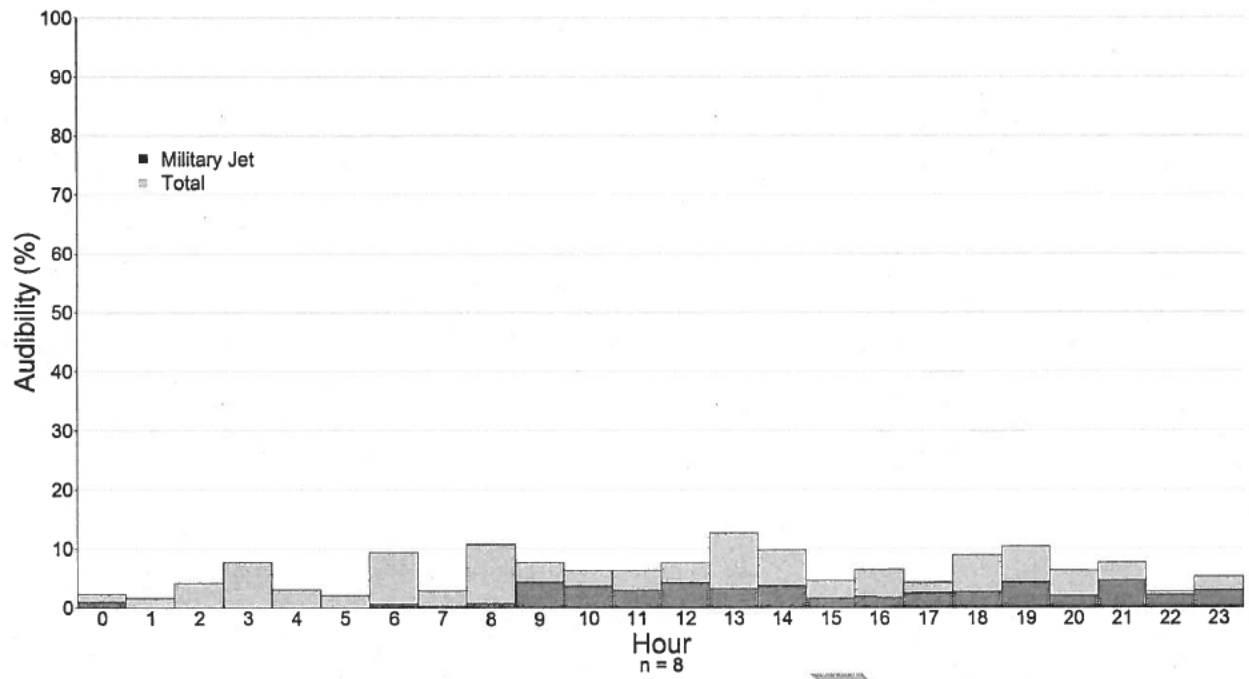
SANJ001



LOPEZ001



SANJ001



Discussion:

Conclusion:

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